

CLAIMS

What is claimed is:

- 1 1. An electrical device comprising:
2 a sheet of insulative material having grooves therein, the sheet of insulative
3 material including:
4 a first planar surface; and
5 a second planar surface
6 a conductive material within the grooves, the conductive material forming
7 electrical traces in the electrical device.
- 1 2. The electrical device of claim 1 wherein the conductive material within
2 the grooves fills the groove and includes a surface coplanar with at least one of the
3 first planar surface or the second planar surface.
- 1 3. The electrical device of claim 1 wherein the first planar surface of the
2 sheet of the insulative material has grooves therein, and wherein the second planar
3 surface of the insulative material has grooves therein.
- 1 4. The electrical device of claim 1 wherein the first planar surface of the
2 sheet of the insulative material has grooves therein that are filled with the
3 conductive material, and wherein the second planar surface of the insulative
4 material has grooves therein that are filled with the conductive material.
- 1 5. The electrical device of claim 4 wherein the conductive material within
2 the grooves on the first planar surface fills the groove and includes a surface
3 coplanar with the first planar surface, and wherein the conductive material within
4 the grooves on the second planar surface fills the groove and includes a surface
5 coplanar with the second planar surface.

1 6. The electrical device of claim 1 further comprising a second sheet of
2 insulative material, the second sheet of insulative material including:
3 a first planar surface; and
4 a second planar surface
5 a conductive material within the grooves of the second sheet of insulative
6 material, the conductive material forming electrical traces in the electrical device,
7 wherein the second sheet of insulative material is attached to the first sheet of
8 insulative material to form a multi-layered electrical device.

1 7. The electrical device of claim 1 wherein one of the first planar surface or
2 the second planar surface is an exterior surface of the electrical device, the exterior
3 surface of the electrical device including features that are flush with the exterior
4 surface of the device.

1 8. The electrical device of claim 7 wherein the features that are flush with
2 the exterior surface of the device are pads.

1 9. The electrical device of claim 7 wherein the exterior surface is ground.

1 10. A system for making a conductive circuit on a substantially non-
2 conductive substrate, the system comprising:
3 an indenter that forms a plurality of indentations on a major surface of the
4 substrate;
5 a plater that plates conductive material on the major surface of the substrate
6 and within the indentations formed in the major surface of the substrate; and
7 a grinder that removes a portion of the conductive material plated on the
8 major surface of the substrate leaving conductive material within the indentations in
9 the major surface of the substrate, wherein the conductive material within at least
10 some of the plurality of indentations is separated from the conductive material
11 within some of the other indentations by non-insulative material.

1 11. The system according to claim 10 wherein the grinder removes a
2 portion of the conductive material within the plurality of indentations.

1 12. The system according to claim 10 wherein the grinder removes a
2 portion of the conductive material within the plurality of indentations and the
3 conductive material over the non-conductive material between the indentations to
4 form a planar surface including non-conductive material and conductive material.

1 13. The system according to claim 10 wherein the indenter includes a
2 plate having a negative of the indentations in the substrate.

1 14. The system of claim 10 wherein the indentations include at least one
2 channel.

1 15. The system of claim 10 wherein the indentations include at least one
2 pad.

1 16. The system of claim 10 wherein the indentations include at least one via.

1 17. The system of claim 10 wherein the indenter is a roller.

1 18. The system of claim 17 wherein the roller includes an interchangeable
2 plate having a negative of the indentations in the substrate.

1 19. The system of claim 10 wherein the indenter includes a plurality of
2 planar surfaces.

1 20. A system for making a conductive circuit on a substantially non-
2 conductive substrate, the system comprising:
3 a first roller apparatus that forms a plurality of indentations on a first major
4 surface of the substrate; and
5 a second roller apparatus that forms a plurality of indentations on a second
6 major surface of the substrate.

1 21. The system for making a conductive circuit on a substantially non-
2 conductive substrate of claim 20 further comprising:

3 a plater that plates conductive material on the first major surface of the
4 substrate and on the second major surface of the substrate and within the
5 indentations formed in the first major surface of the substrate and in the second
6 major surface of the substrate; and

7 a grinder apparatus that removes a portion of the conductive material plated
8 on the first major surface of the substrate leaving conductive material within the
9 indentations in the first major surface of the substrate, and removes a portion of the
10 conductive material plated on the second major surface of the substrate leaving
11 conductive material within the indentations in the second major surface of the
12 substrate, wherein the conductive material within at least some of the plurality of
13 indentations is separated from the conductive material within some of the other
14 indentations by non-insulative material.

1 22. The system for making a conductive circuit on a substantially non-
2 conductive substrate of claim 21 wherein the grinder apparatus is comprised of a
3 plurality of grinders.

1 23. The system for making a conductive circuit on a substantially non-
2 conductive substrate of claim 20 wherein the first roller apparatus is comprised of a
3 plurality of rollers.

1 24. A method for forming a conductive circuit on a substantially non-
2 conductive substrate comprising:

3 indenting a major surface of a substrate with a plurality of features;
4 plating the major surface and the indentations formed with a conductive
5 layer; and

6 removing a portion of the conductive layer leaving at least one of the
7 plurality of the indentations filled with conductive material separated from at least

8 one other of the plurality of the indentations filled with conductive material
9 separated by non-conductive material.

1 25. The method of claim 24 wherein the major surface of the substrate is
2 indented with a roller.

1 26. The method of claim 24 wherein the major surface of the substrate is
2 indented with a plurality of indenting devices.

1 27. The method of claim 24 wherein removing a portion of the conductive
2 layer includes grinding a portion of the conductive layer.

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2 28. A conductive circuit formed on a substantially non-conductive substrate
3 according to the method of claim 24.

1 29. A method for forming a conductive circuit on a substantially non-
2 conductive substrate comprising:

3 indenting a first major surface of a first substrate with a first plurality of
4 features;

5 indenting a second major surface of a first substrate with a second plurality
6 of features;

7 plating the first major surface and the indentations formed in the first major
8 surface with a conductive layer; and

9 plating the second major surface and the indentations formed in the second
10 major surface with a conductive layer.

1 30. The method of claim 29 further comprising:

2 removing a portion of the conductive layer on the first major surface leaving
3 at least one of the plurality of the indentations in the first major surface filled with
4 conductive material separated from at least one other of the plurality of the

5 indentations in the first major surface filled with conductive material separated by
6 non-conductive material; and
7 removing a portion of the conductive layer on the second major surface
8 leaving at least one of the plurality of the indentations in the second major surface
9 filled with conductive material separated from at least one other of the plurality of
10 the indentations in the second major surface filled with conductive material
11 separated by non-conductive material.